REMARKABLE FORMS IN THE DESMID FLORA OF A SMALL MOUNTAIN BOG IN THE FRENCH JURA

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ABSTRACT – The desmid flora of two small bog pools in the French Jura is investigated. The morphological variability of 16 taxa is described and taxonomically discussed. A number of these taxa showed remarkable deviations in radiation or ornamentation as compared with their usual manifestation. These deviating morphae might be related to an ecological stress situation caused by a desiccating habitat and high irradiance intensity. One taxon, *Actinotaenium geniculatum*, is newly described.

RÉSUMÉ – La flore desmidiale de deux petites mares tourbeuses dans le Jura français est examinée. La variabilité morphologique de 16 taxons est décrite et leur taxonomie est discutée. En comparaison de leur manifestation normale, un certain nombre de ces taxons montraient des déviations remarquables dans leur radiation ou leur ornementation. Ces formes aberrantes pourraient se rattacher à une situation de stress écologique, provoquée par un habitat s'asséchant et une insolation intense. *Actinotaenium geniculatum* est décrit comme nouveau taxon.

KEY WORDS : desmids, morphological variability, taxonomy, Jura, France.

INTRODUCTION

New desmid taxa are frequently described on the basis of only one or a very few specimens. In doing so, often excessive taxonomic value is attached to small morphological differences, which has led to a large number of taxonomically insignificant varieties and forma's (Fritsch, 1953; Grönblad & Růžička, 1959). Although morphological variability was already recognized at an early date (Borge, 1896; G.S. West, 1899; Playfair, 1910; Ducellier, 1915), correct taxonomic consequences – i.e. lumping of taxa – were only seldom attached to it (cf. Lefèvre, 1939).

Only in recent times a number of papers appeared in which the taxonomy of desmid species has been revised on the basis of morphological variation within a larger population (e. g. Péterfi, 1972; Sormus & Bicudo, 1974; Gerrath,

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1983; South, 1984; Kouwets, 1984). At present, however, the variability of many common taxa is still poorly known and not seldom only a few, often inadequate figures are available (Brook, 1984).

In two small pools in *Sphagnum*-bog in the French Jura a number of desmid taxa were encountered showing a remarkable morphological variation. In addition, several rare taxa were found of which information concerning their variability is self-evidently scarce. In the present paper a list is given of all taxa encountered; 16 taxa are depicted and their morphology and taxonomy are discussed.

MATERIAL AND METHODS

On the south-east border of Lac des Rousses (French Jura, alt. 1058 m), a boggy zone has developed which is traversed by several streamlets. Vegetation is characterized by Ericaceae and mosses («tourbière à Sphaignes», see Allorge & Denis, 1919), with a.o. *Calluna vulgaris, Vaccinium oxycoccus, Andromeda polifolia, Eriophorum* spp., *Drosera intermedia, D. rotundifolia* and *Sphagnum* spp., while on the edges of the bog and along the streamlets also *Menyanthes trifoliata, Potentilla palustris, Parnassia palustris, Dactylorhiza maculata* and *Carex* spp. occur. In this terrain several smaller and larger pools and hollows are situated. The material that is subject of the present study was collected on 20.07.1984 on two neighbouring sites :

SITE 1. – Small pit, surface area about 1 m^2, almost completely filled in with *Sphagnum cuspidatum*.

SITE 2. – System of interconnected small pools, each measuring a few m^2, with *Menyanthes trifoliata* and *Drepanocladus exannulatus*.

At the time of sampling, the pools were nearly dried up and the material was collected by squeezing out mosses and bottom deposits. Shortly after sampling the material was fixed with formaldehyde to a final concentration of about 4 %. It was examined light microscopically and drawings were made with the aid of a drawing tube. For SEM observation the samples were rinsed in distilled water, subsequently transferred to 1 % glutaraldehyde for one hour at room temperature, rinsed in double-distilled water, dehydrated in an alcohol series and critical-point dried with liquid CO_2. The material was finally gold-sputtered and examined with a Cambridge Stereoscan Mark 2A.

OBSERVATIONS

LIST OF DESMID TAXA ENCOUNTERED

In table I a complete list of desmid taxa encountered during the present study on sites 1 and 2, respectively, is given. Taxa discussed in the text are marked with an asterisk. Relative abundance : rr = very rare, r = rare, + = regular, c = common, cc = very common.

		SITE 1	SITE 2
	ZYGNEMATALES		
	Mesotaeniaceae		
	Cylindrocystis brebissonii (Menegh. ex Ralfs) De Bary	-	rr
	Netrium digitus (Ehr. ex Ralfs) Itzigs. & Rothe	r	[illegible]
	N. oblongum (De Bary) Lütkem.	+	+
	DESMIDIALES		
	Peniaceae		
	Penium exiguum W. West	-	rr
	P. polymorphum (Perty) Perty	rr	rr
	Closteriaceae		
	Closterium acutum Bréb. var. linea (Perty) W. & G.S. West	r	+
	Desmidiaceae		
*	Actinotaenium adelochondrum (Elfv.) Teil.	-	rr
	A. cucurbita (Bréb.) Teil.	+	c
*	A. geniculatum spec. nov.	r	+
	A. inconspicuum (W. & G.S. West) Teil.	rr	c
*	A. pinicolum Rosa	rr	rr
	A. silvae-nigrae (Raban.) Kouw. & Coes. var. silvae-nigrae	rr	r
	A. silvae-nigrae (Raban.) Kouw. & Coes. var. parallelum (Krieg.) Kouw. & Coes.	r	rr
*	A. subtile (W. & G.S. West) Teil.	rr	r
	Pleurotaenium minutum (Ralfs) Delp.	rr	r
	Tetmemorus brebissonii (Menegh.) Ralfs ex Ralfs var. minor De Bary	-	r
	T. laevis (Ralfs) Delp.	-	r
	Euastrum ampullaceum Ralfs	-	rr
	E. binale (Turp.) Ehr. ex Ralfs var. gutwinskii (Schmidle) Homf.	+	+
	E. subalpinum Messik.	-	rr
	Cosmarium amoenum Bréb. in Ralfs	-	r
	C. cymatonotaphorum W. West	-	+
*	C. difficile Lütkem.	-	rr
	C. exiguum Arch. var. pressum W. & G.S. West	-	rr
	C. obliquum Nordst.	-	rr
	C. pseudoexiguum Racib.	rr	-
	C. pseudopyramidatum Lund.	-	rr
*	C. pygmaeum Arch.	c	rr
*	C. sphagnicolum W. & G.S. West	c	+
	C. subtumidum Nordst.	-	+
	C. truncatellum Perty	-	rr
*	Xanthidium tenuissimum (Arch.) Turn.	-	rr
*	Staurodesmus extensus (Anderss.) Teil.	cc	r
	S. glaber ((Ehr.) ex Ralfs) Teil. var. hirundinella (Messik.) Teil	-	rr
*	S. omearne (Arch.) Teil.	-	+
*	S. spencerianus (Mask.) Teil.	-	cc
	Staurastrum brachiatum (Ralfs) ex Ralfs	-	r
*	S. echinatum Bréb. in Ralfs	-	rr
*	S. furcatum (Ehr. ex Ralfs) Bréb.	c	r
	S. hirsutum (Ehr.) ex Bréb. in Ralfs	-	r
	S. hystrix Ralfs	r	rr
	S. inconspicuum Nordst.	r	r
*	S. margaritaceum (Ehr.) Menegh. ex Ralfs	r	r
	S. orbiculare Ralfs ex Ralfs var. ralfsii W. & G.S. West	-	rr
	S. polymorphum Bréb. var. divergens Nyg.	-	rr
*	S. punctulatum Bréb. in Ralfs var. pygmaeum (Bréb. in Ralfs) W. & G.S. West	-	r
	S. scabrum Bréb. in Ralfs	r	r
*	S. simonyi Heimerl	+	+
	S. tetracerum Ralfs ex Ralfs var. irregulare (W. & G.S. West) Brook	-	r
	Bambusina borreri (Ralfs) Cleve	c	rr
	Teilingia granulata (Roy & Biss.) Bourr. ex Comp.	-	+

Table I — List of desmid taxa found on sites 1 and 2, respectively. See also text.

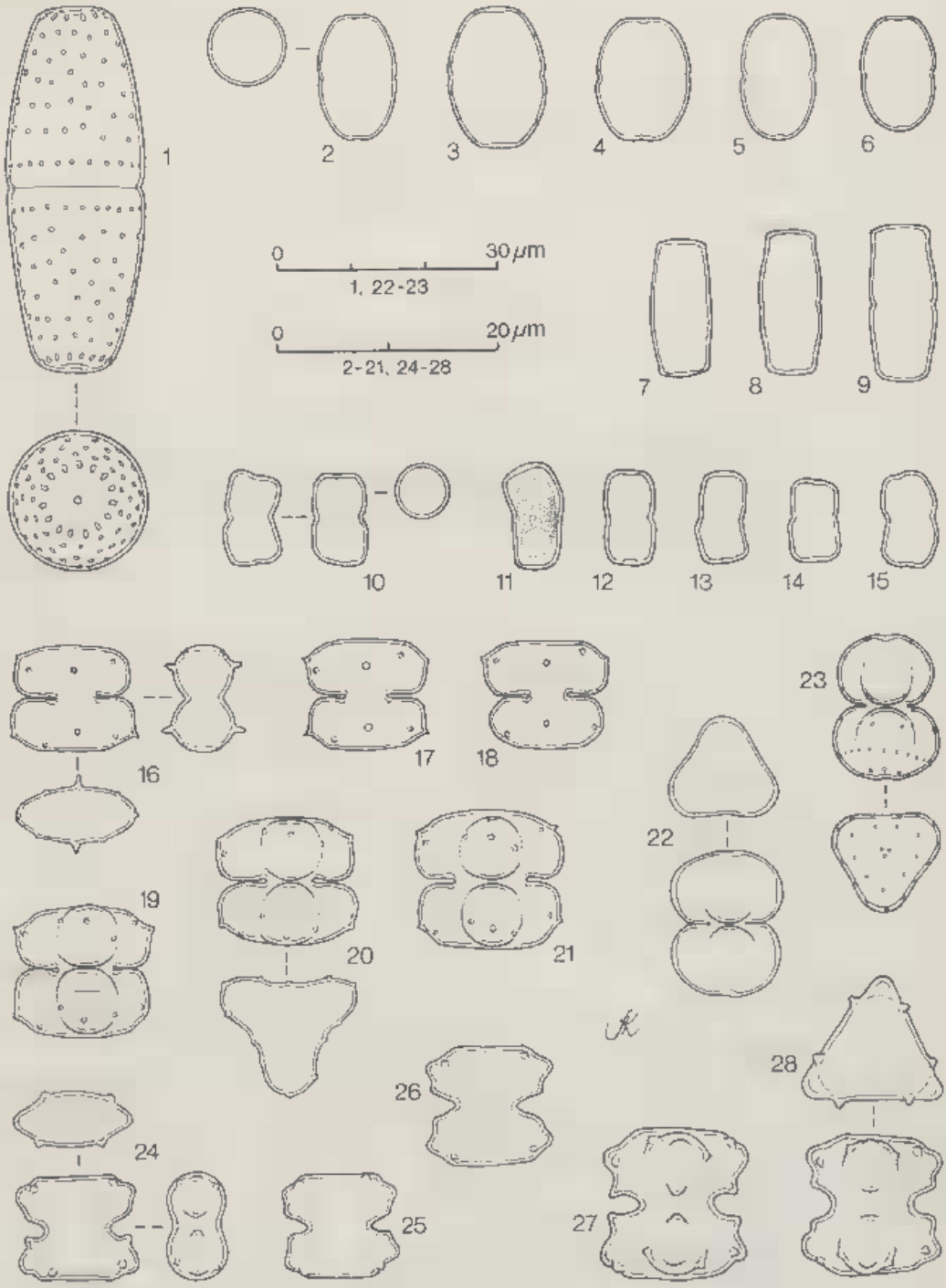

Plate 1 — Fig. 1 : *Actinotaenium adelochondrum* (Elfv.) Teil. var. *adelochondrum*. Figs. 2-6 : *A. subtile* (W. & G.S. West) Teil. — Figs. 7-9 : *A. pinicolum* Rosa. — Figs. 10-15 : *A. geniculatum* spec. nov. (fig. 10 iconotypus in both two different lateral views and in apical view). — Figs. 16-21 : *Cosmarium pygmaeum* Arch. (figs. 16-18 : facies 2; figs. 19-21 : facies 3). — Figs. 22-23 : *C. aifficile* Lütkem. facies 3. — Figs. 24-28 : *C. sphagnicolum* W. & G.S. West (figs. 24-26 : facies 2; figs. 27-28 : facies 3).

CRITICAL REMARKS ON SOME SELECTED TAXA

Actinotaenium adelochondrum (Elfv.) Teil var. ***adelochondrum***
Pl. 1, fig. 1.

Notwithstanding the fact that *A. adelochondrum* is not really a rare species, only a very few adequate figures have been published and its morphological variability is poorly known (Růžička, 1981). According to Elfving (1881) the semicells of the nominal variety are gradually tapering towards a truncate, sometimes indented apex, which is confirmed by the corresponding figures (Elfving, l. c., fig. 13). The cell wall is provided with scattered, inconspicuous pores. In var. *kriegeri* (Messik.) Růz., on the other hand, the apex is more rounded and gradually fading into the sides of the semicell. In addition is has on an average slightly smaller dimensions. However, intermediates between both varieties are known (Růžička, 1981).

In none of the reports published after Elfving (1881) that are assumed to refer to the nominal variety of *A. adelochondrum*, mention is made of a dented apex : the – mostly poor – figures always show more or less truncate apices (cf. Heimerl, 1891; West & West, 1904; Borge, 1936; Růžička, 1981). Krieger & Gerloff (1969) and Růžička (1981) report the regular presence of a ring of smaller, closer-set pores on either side of the isthmus.

The nominal variety of *A. adelochondrum* was very rare in the material from site 2 (see pl. 1, fig. 1). The semicells are characterized by the slightly convexe sides and the truncate apex. Scrobiculae with pores are arranged scattered over the cell wall. In addition to isthmal pore-rings, a ring of slightly elongated scrobiculae is present just under the apex of the semicell. In the centre of the apex a dent with a large pore is visible (the apical ornament is best seen in top view). Cell length 41.5 - 51 µm, diameter 19 - 20 µm. At present it is not known whether the apical pore-ring is of a common occurrence in var. *adelochondrum*; its possible taxonomic value as a distinguishing character against var. *kriegeri* therefore as yet remains unknown.

Actinotaenium geniculatum spec. nov.
Pl. 1, figs. 10-15; pl. 6, figs. 1-2.

In the samples from both pools a small and unknown desmid form was encountered. In frontal view the semicells are quadrate to rectangular in outline. The sides are sometimes slightly convexe or concave; the apex is strongly truncate and regularly has a central dent. In apical view the cells are circular, pointing to a relation with the genus *Actinotaenium* Teil. The most striking character of the present form, however, are the two semicells joining at an obtuse angle, giving the cell a bent («geniculate») appearance. The degree in which this character is visible, however, depends on the position of the cell in question (cf. pl. 1, fig. 10). The sinus is of an irregular shapes, but always shallow and widely dilated. In a few specimens it was visible that the cell contains but one chloroplast with one pyrenoid (pl. 1, fig. 11). SEM observation showed that the

cell wall is closely set with comparatively large scrobiculae with pores (pl. 6, figs. 1-2). Dimensions : length 6.5 - 9.5 µm, diameter 4 - 5.5 µm.

The above discussed form is not identifiable with any of the desmid taxa published so far, so that it is described as a new species :

Actinotaenium geniculatum Kouwets, spec. nov.

Diagnosis : Cellulae parvulae; semicellulae cylindricae fronte conspectae, latitudine longitudinem fere aequante, propemodum quadratae lateribus plerumque leviter convexis vel concavis, apice valde truncato saepenumero excavatione centrali munito. Semicellulis angulo obtuso inter se connectis cellula infracta apparet. Sinus paulum excavatus et late apertus forma irregulari. Paries cellulae magnis scrobiculis poris munitis ornatus.

Dimensiones : longitudo 6.5 - 9.5 µm, diameter 4 - 5.5 µm.

Holotypus : figura nostra pl. 1, fig. 10.

The bent cell shape forms no exception within the genus *Actinotaenium* : also *A. incurvum* (Grönbl.) Rino shows this character in a higher or less degree (Rino, 1972; compare also *Closterium infractum* Messik., see Růžička, 1977).

Actinotaenium pinicolum Rosa

Pl. 1, figs. 7-9.

A. pinicolum is characterized by a slight constriction just under the apex and it can hardly be confused with any other *Actinotaenium* species (Růžička, 1981). It occurred sporadically in both pools investigated. The cell shape agrees fairly well with the figures in Rosa (1959) and Růžička (1981). The dimensions, however, are clearly smaller; length 12 - 14.5 µm, diameter 5.5 - 6 µm, whereas Růžička (l. c.) gives 16 - 23 µm and 7 - 9 µm, respectively. Cell wall pores are not visible light microscopically. After the description by Rosa (1959), this species has never been reported in literature unambiguously : only Broady (1979) mentioned a cf. *A. pinicolum*, and judging from his figures his find represents a different species. Rosa (1959) found the species in the edaphon of pine-woods in South-Bohemia, at pH 4 - 4.6. It is not known whether in the jurassic study area it only occurred as a rare tychoplantic species, or also (maybe more abundantly) in the edaphon of the moorland surrounding the pools.

Actinotaenium subtile (W. & G.S. West) Teil.

Pl. 1, figs. 2-6.

A. subtile is only seldom reported and figured in literature, and its variability is poorly known (Růžička, 1981). The present author found the species in both pools investigated, as a very rare organism. Cell shape and dimensions are somewhat variable. The apex is mostly rather broadly truncate (pl. 1, figs. 2-4) but sometimes rounded or slightly attenuated (pl. 1, figs. 5-6); a central dent is always present. Light microscopically, pores are only visible in optical section of the cell wall (pl. 1, fig. 3). Dimensions : length 15 - 20 µm, diameter 10 - 13 µm. The morphology of most of our specimens indeed points to *A. subtile*,

but the differences with the equally rare species *A. mooreanum* (Arch.) Teil. are very small (cf. Růžička, 1981).

Cosmarium difficile Lütkem.
Pl. 1, figs. 22-23.

In the material under discussion the semicells of this species are more or less oval in outline, with maximal breadth on or just above the middle. The ornamentation of horizontal rows of coarse pores is visible only occasionally (pl. 1, fig. 23). The sides sometimes appear slightly thickened (pl. 1, fig. 22). Dimensions : length 19 - 20 µm, breadth 13 - 15 µm, which is about the lower limit given for this species by Krieger & Gerloff (1969). In apical view, however, the semicells are trigonal with concave sides and our material obviously represents a triradiate form of the nominal variety of *C. difficile*. Similar forms have already been reported by Insam & Krieger (1936), as *C. difficile* forma *trigonum*, and by Grönblad (1942), as *C. difficile* var. *interseptum* (Jacobs.) Grönbl. forma *triquetrum* (cf. Krieger & Gerloff, 1969). Such triradiate morphae, however, that are known from a fair number of usually biradiate species should not be described as variety or forma and provided with a name of taxonomic value (Grönblad & Růžička, 1959). Our material therefore at best is classified as triradiate facies, or facies 3 (cf. Teiling, 1950, 1967; Růžička, 1975a; see also discussion). The form was very rare on site 2; the biradiate facies was not encountered at all.

Cosmarium pygmaeum Arch.
Pl. 1, figs. 16-21.

Characteristic biradiate specimens of the nominal variety of *C. pygmaeum* were collected on both sites in different numbers : site 1 +; site 2 : rr. They have a small, conical central papilla on their semicells, while the subapical granules usually are placed asymmetrically (pl. 1, figs. 16-18; cf. Kouwets, 1987). Dimensions : length 9 - 10 µm, breadth 10 - 12 µm, thickness 5 - 6 µm.

Together with these biradiate forms, however, triradiate specimens were also encountered (pl. 1, figs. 19-21), and they were even more common than the biradiate cells on site 1 : c; site 2 : rr. In apical view these specimens are triangular with concave sides provided with a very small central papilla. Dimensions : length 12 - 13 µm, breadth 11.5 - 13 µm, which is slightly larger than the biradiate form. The triradiate facies had not previously been reported in literature.

Cosmarium sphagnicolum W. & G.S. West
Pl. 1, figs. 24-28.

The biradiate cells of the nominal variety of *C. sphagnicolum*, that were encountered in both pools (site 1 : c; site 2 : r), agree perfectly with the forms reported previously from the Auvergne (Kouwets, 1987). Dimensions : length 9 - 12 µm, breadth 10 - 12.5 µm, thickness about 5 µm (pl. 1, figs. 24-26).

Besides these biradiate specimens, triradiate cells were regularly found on site

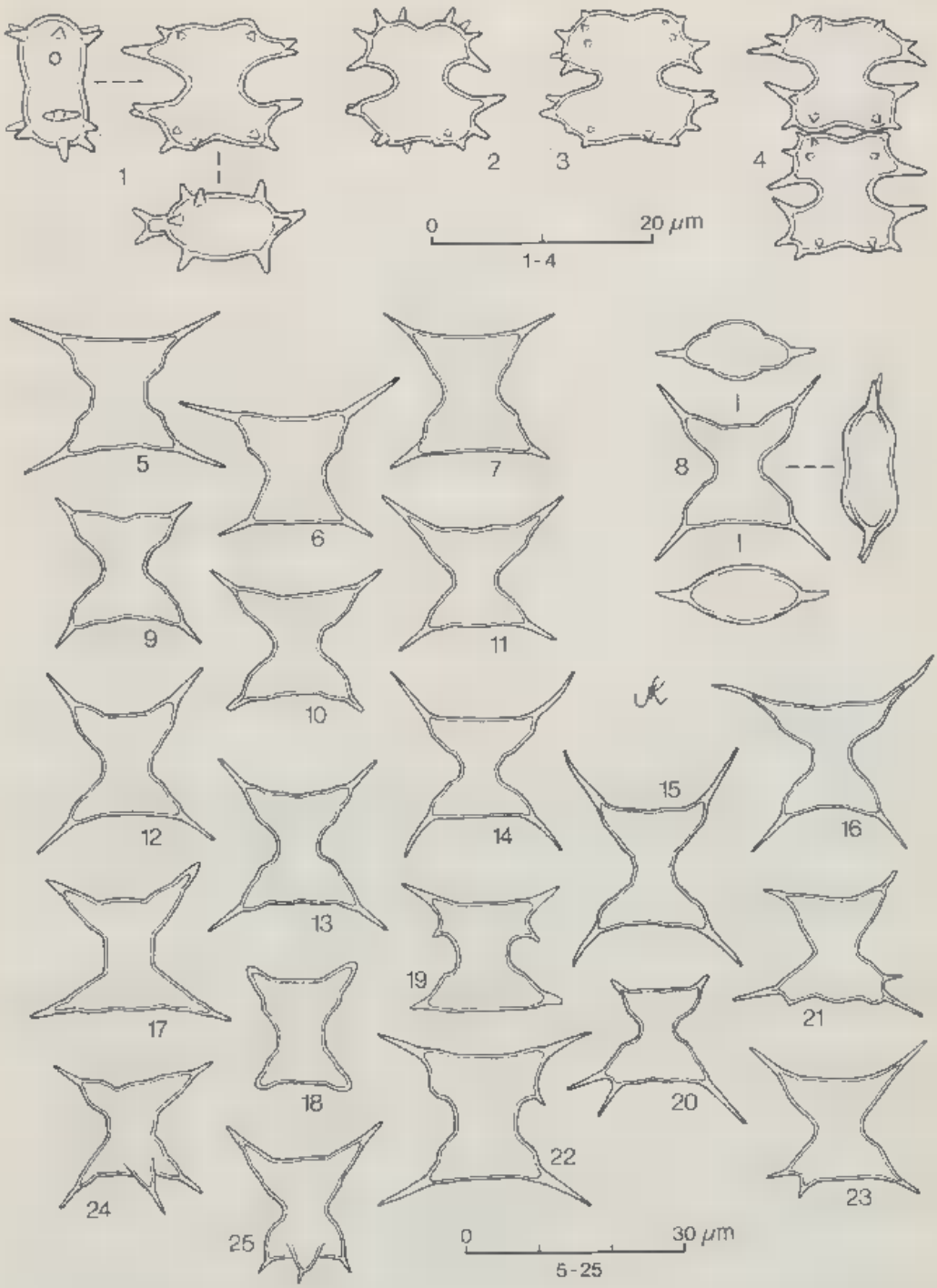

Plate 2 — Figs. 1-4 : *Xanthidium tenuissimum* (Arch.) Turn. (fig. 4 : two recently divided daughter cells). — Figs. 5-25 : *Staurodesmus extensus* (Anderss.) Teil. (figs. 5-23 : facies 2; figs. 24-25 : janus 2 + 3).

2 (abundance : +), while these were not encountered in the material from site 1. The cells are triangular in apical view with straight sides and rather acutely rounded angles. Dimensions are slightly larger than in the biradiate specimens : length 13 - 14 µm, breadth 12 - 13 µm. This triradiate facies had not previously been reported in literature.

Xanthidium tenuissimum (Arch.) Turn.
Pl. 2, figs. 1-4.

In the material collected on site 2, very rarely a small desmid was found that is reminiscent of *X. tenuissimum* (syn. : *Arthrodesmus tenuissimus* Arch.), and particularly of a form described by Dick (1926) as forma *waldensis*. This form differs from the nominal form by the presence of an extra spine on the angles of the semicell. Our material is very variable, however, especially as concerns number and length of the spines on the cell wall. Moreover, all specimens encountered are dichotypical. Some of the semicells are somewhat intermediate between the nominal form and forma *waldensis* (pl. 2, fig. 1, upper semicell) but one or more extra spines are almost always present along or just inside the margins of the angles. Occasionally one of the spines is forked (pl. 2, fig. 1, lower semicell). Dimensions, including spines : length 11 - 13 µm, breadth 13 - 16 µm; thickness, without spines, about 6 µm. In the present author's opinion, forma *waldensis* falls within the range of variability of the nominal form, and therefore is considered synonymous with it.

Staurodesmus extensus (Anderss.) Teil.
Pl. 2, figs. 5-25.

Characteristic specimens of the nominal variety of *S. extensus* were found very scarcely on site 2 : rr (pl. 2, fig. 5). In addition, a few aberrant forms were encountered (abundance : r) but these, on the contrary, were very common on site 1 : cc. In most of these last mentioned anomalous forms the elongated isthmus is still more or less recognizable but the basal angles of the semicell show various intermediates between well developed and totally absent. The apical angles, however, are often extended and their spines sometimes reduced (pl. 2, figs. 6-16; two extreme forms are given on pl. 2, figs. 17 and 18). Dimensions of the cells, without spines : length 13 - 17 µm, breadth 10 - 16 µm, thickness 7 - 8 µm; length of the spines up to 9 µm). Such anomalous forms show resemblance to *S. isthmosus* (Heimerl) Croasd., a poorly known species, differing from *S. extensus* mainly in the gradual transition of its apical angles into the broad basis of the spines (Teiling, 1967). However, in most of the published figures classified as *S. isthmosus* by Teiling (l. c.) this character is very indistinct.

A number of specimens possessed an additional spine on one or, more seldom, both of the upper or basal angles of the semicell (pl. 2, figs. 19-25). Besides, a very small number of cells was found with one biradiate and one triradiate semicell (pl. 2, figs. 24-25; = janus 2 + 3 *sensu* Teiling, 1950, 1967). In this connection the report of Grönblad (1942) of *Staurastrum trigonum* (Boldt)

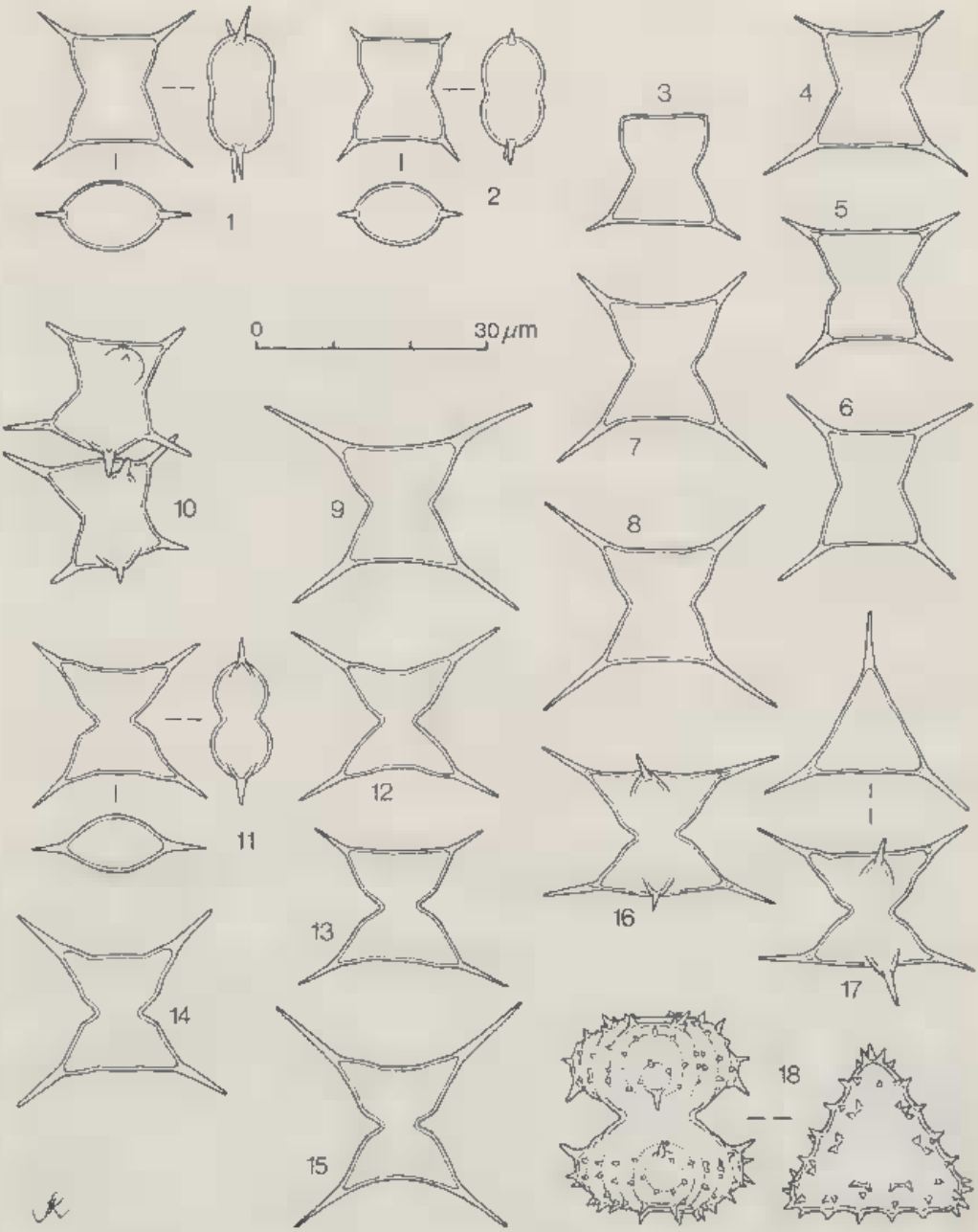

Plate 3 — Fig. 1-10 : *Staurodesmus omearae* (Arch.) Teil. (figs. 1-9 : facies 2; fig. 10 : facies 3, two recently divided daughter cells). — Figs. 11-17 : *S. spencerianus* (Mask.) Teil. (figs. 11-15 : facies 2; figs. 16-17 : facies 3). — Fig. 18 : *Staurastrum echinatum* Bréb. in Ralfs.

Kossinsk., and its var. *simplex* Grönbl. is interesting. Teiling (1967) classified these forms under *Staurodesmus isthmosus*, together with a form depicted under *Arthrodesmus incus* (Bréb.) Hass. by Grönblad (l. c.) ! In my opinion,

however, these forms are identical with the present material; Grönblad (l. c.) found them in one and the same sample from ■ «Sphagnum Schlenke». Compare also the similar *Arthrodesmus octocornis* (Ehr. ex Ralfs) Arch. forma, in Grönblad (1921).

Staurodesmus omearae (Arch.) Teil.
Pl. 3, figs. 1-10.

S. omearae (not : *omearii*; see Růžička, 1973), was encountered on site 2 only (abundance : +). The material is characterized by its comparatively broad isthmus which is one of the distinguishing marks of this species (cf. Archer, 1858). The apex is mostly straight though sometimes convexe or concave. The sides are straight to convexe, while some specimens show the tendency to develop a faint basal angle (pl. 3, figs. 5 and 8). Length and robustness of the spines are very different : in some semicells the spines are even totally absent (pl. 3, fig. 3). Most of the cells found are biradiate, but a very few triradiate cells are also encountered (abundance : rr; pl. 3, fig. 10). Dimensions, without spines : 13-15 µm, breadth 10 - 14 µm, thickness about 8 µm; length of spines up to 11.5 µm. The present material resembles the forms reported by Borge (1936). Compare also forma *inflatus*, described by Nygaard (1978, publication invalid : ICBN Art. 37); this form, however, is slightly larger. Good figures of the triradiate facies of *S. omearae* are given by e.g. Růžička (1973) and Lenzenweger (1981, 1986).

The little known and scarcely mentioned biradiate species *S. quadratus* (Schmidle) Teil. and *S. boergesenii* (Messik.) Croasd. are also very much resembling the material under study (cf., e.g. Croasdale & Grönblad, 1964). Both species are considered synonymous and classified as *Arthrodesmus quadratus* (Schmidle) Bicudo by Prescott, Bicudo & Vinyard (1982). Their possible synonymy with *S. omearae* needs to be investigated.

Staurodesmus spencerianus (Mask.) Teil.
Pl. 3, figs. 11-17.

A biradiate form of this taxon was very commonly encountered on site 2 (abundance : cc), while the more «typical» triradiate facies was less common (+). The cells are characterized by their relatively slender isthmus and their acutely rounded sinus, which made them readily distinguishable from the co-occurring *S. extensus* and *S. omearae* (see above; cf. also Förster, 1974). The apex is more or less concave; the upper angles are mostly slightly swollen. Length of spines is variable. The sides are concave, usually with a more or less pronounced basal angle and a slight constriction in their middle (pl. 3, figs. 11-15). Dimensions, without spines : length 13 - 16 µm, breadth 13 - 17 µm, thickness 7 - 8 µm; length of the spines 4 - 11 µm. The triradiate forms agree fairly well with those reported from comparable sampling sites in the Auvergne (Kouwets, 1987). The dimensions are a little bit small for this taxon; see, however, forma *minor* in Borge (1892; cf. also Teiling, 1967), and var. *cruciatus* (Krieg.) Teil. (cf. Grönblad, 1963). Possibly, these smaller forms represent a separate, acido-

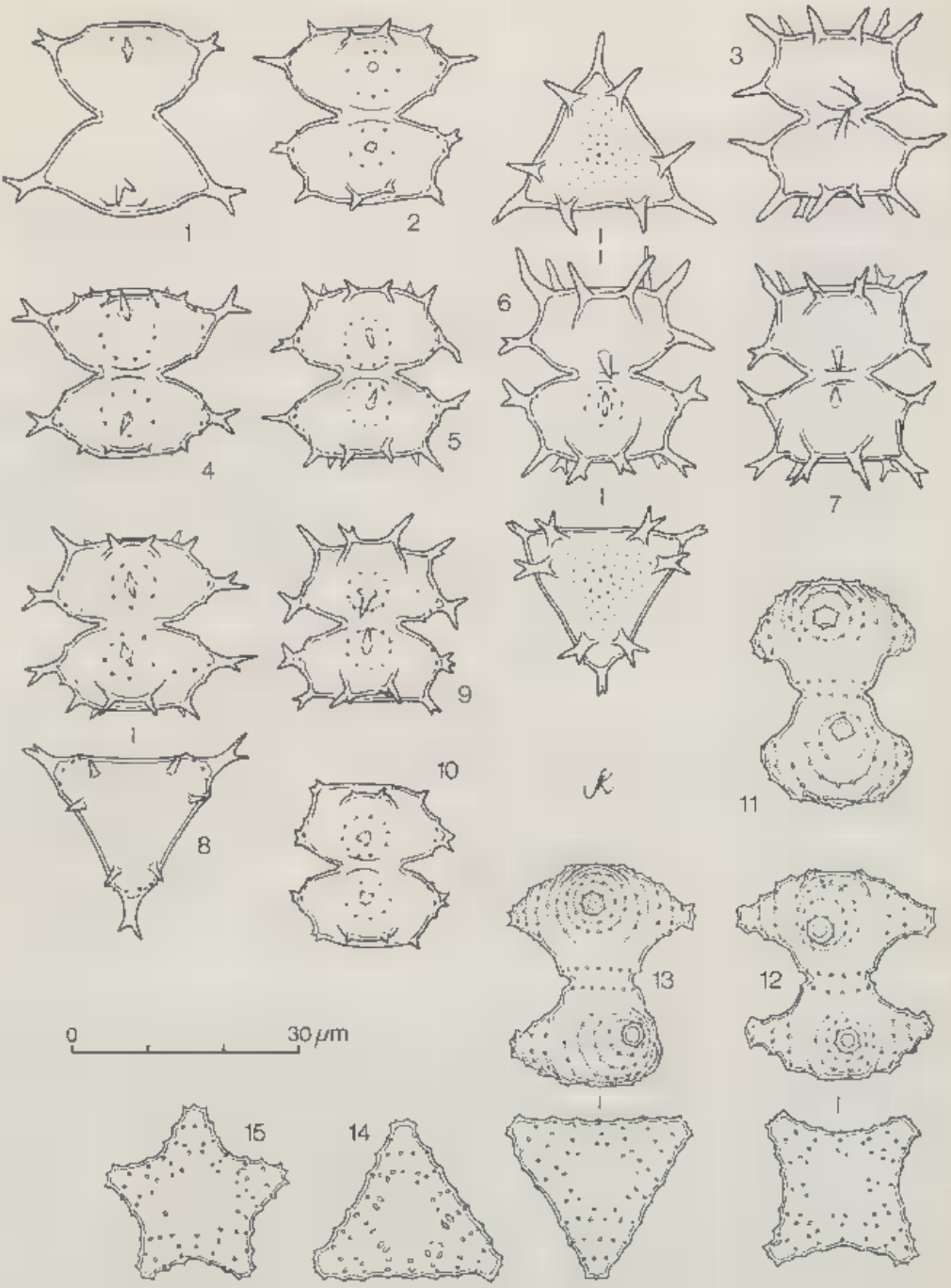

Plate 4 — Figs. 1-10 : *Staurastrum furcatum* (Ehr. ex Ralfs) Bréb. — Figs. 11-15 : *S. margaritaceum* (Ehr.) Menegh. ex Ralfs (fig. 11-12 : facies 4; figs. 13-14 : facies 3; fig. 15 : facies 5; figs. 14-15 : apical view only).

philous taxon, which might often be confused with *S. omearae* : compare the figures of last mentioned species in e.g. Grönblad (1956) and Růžička (1972); see also Coesel & Hoogendijk (1975).

Staurastrum echinatum Bréb. in Ralfs
Pl. 3, fig. 18.

This rare taxon occurred in very small numbers on site 2, and unfortunately only one good figure could be made. The sinus is acute and widely dilated and the angles of the semicells are provided with a rather robust spine. The characteristic furcate spines on the apex, however, are small and sometimes simple. Dimensions are rather small : the depicted cell measures 26 x 22 µm. The present material agrees well with the emended description given by Heimans (1926), who cleared up the very confused taxonomy of *S. echinatum* using the original material collected by De Brébisson, and material collected by Beyerinck (cf. Beyerinck, 1926). As far as known, however, also after this thorough study no reports undoubtedly belonging to *S. echinatum* have been published (cf. Heimans, 1969). Consequently the ecology of *S. echinatum* is poorly known. Beyerink (l. c.) found it in acid, oligotrophic environment among several taxa also found during the present study. *S. echinatum* is probably closely related to the equally rare *S. arnellii* Boldt var. *spiniferum* W. & G.S. West (compare, e.g. Lenzenweger, 1982).

Staurastrum furcatum (Ehr. ex Ralfs) Bréb. var. ***furcatum***
Pl. 4, figs. 1-10.

This taxon was encountered on both sampling sites in different numbers (see table I). Both populations showed a similar morphological variability. All specimens observed are triradiate. In frontal view the shape of the semicells ranges from fusiform to trapeziform. The angles of the semicells are provided with at most one terminal and two apical spines, which may vary from completely reduced to robust and curved or forked. The angles in addition are frequently encircled by small granules or spinules. Dimensions of the cells, without spines : length 21 - 25.5 µm, breadth 18 - 23 µm. Our material agrees very well with that erroneously described under *S. spinosum* Bréb. ex Ralfs, by Péterfi (1973; cf. Compère, 1976). Almost all forms described by Péterfi (l. c.) from different populations were also found in each population of the present material. On the one hand, specimens strongly resembling «typical» *S. furcatum* occurred (pl. 4, fig. 7), on the other hand forms similar to the nominal variety of *S. aciculiferum* (W. West) Anderss. were found (pl. 4, fig. 4). Last mentioned taxon is considered a variety of *S. furcatum* by Péterfi (1973), but the large number of intermediate forms in my opinion favours a synonymization, together with *S. spicatum* W. & G.S. West, and *S. furcatum* var. *aculeatum* Schmidle. The presence of circles of granules around the angles of the semicells do not form a character with great taxonomic value, as was already stated by West, West & Carter (1923). *S. furcatum* prefers acid, oligotrophic environments, and the

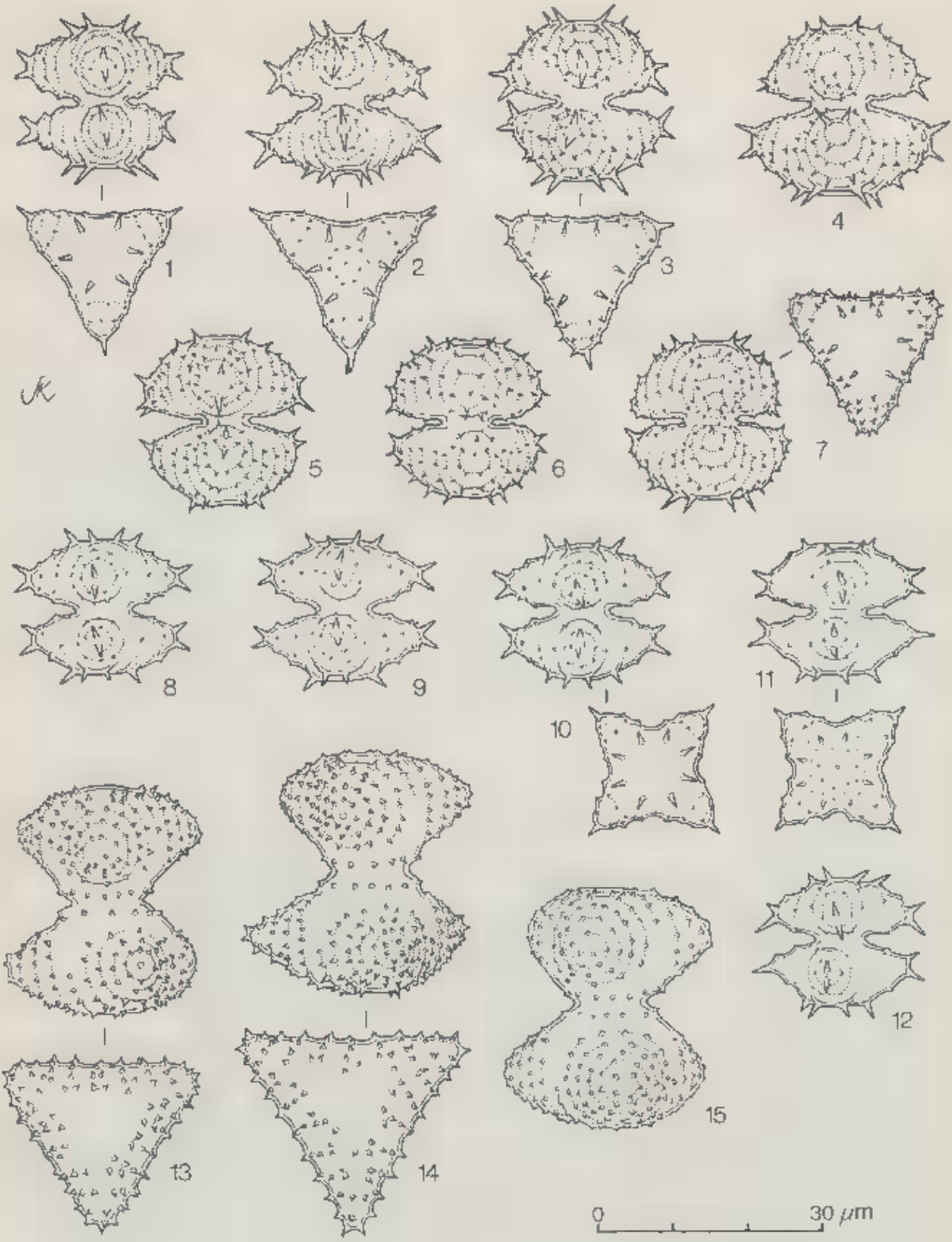

Plate 5 – Figs. 1-12 : *Staurastrum simonyi* Heimerl (figs. 1-9 : facies 3; figs. 10-12 : facies 4). Figs. 13-15 : *S. punctulatum* Bréb. in Ralfs var. *pygmaeum* (Bréb. in Ralfs) W. & G.S. West.

predominance of either the «*furcatum*» or the «*aciculiferum*» form might reflect slight environmental differences.

Staurastrum margaritaceum Ehr. ex Ralfs
Pl. 4, figs. 11-15.

In the present material from both sampling sites tri- and quadriradiate forms of this taxon were occurring in comparable though small numbers, while on a few occasions janus 3+4 forms were found. Only once a 5-radiate specimen was encountered (pl. 4, fig. 15). The length of the arms is rather variable; a quadriradiate cell with very short arm is depicted on pl. 4, fig. 11, Pl. 4 fig. 14 shows a triradiate form with ▪ rather strongly developed apical ornamentation. Dimensions of the cells : length 28 - 30 μm, breadth 20 - 26 μm. Originally, this species was described as being 5- to 7-radiate (cf. Ralfs, 1848). According to the present concept, however, in its most characteristic form it is quadriradiate (cf. Růžička, 1975b; compare also Prescott, Bicudo & Vinyard, 1982), whereas tri-, 5-, 6- or 7-radiate facies are only seldom reported (see, e.g., Croasdale & Grönblad, 1964; Grönblad, 1956; Scharf, 1985).

Staurastrum punctulatum Bréb. in Ralfs var. ***pygmaeum*** (Bréb. in Ralfs) W. & G.S. West
Pl. 5, figs. 13-15.

The present material of this taxon, that was rarely occurring on site 2, agrees very well with the report of Ruzicka (1964). All specimens encountered are triradiate. A distinguishing character of var. *pygmaeum* is formed by the cell wall ornamentation consisting of small conical warts or spinules, whereas the nominal variety has only granules (West & West, 1911). Dimensions : length 29 - 33 μm, breadth 25 - 30 μm. Of var. *pygmaeum* only ▪ very few reports with good figures are available. Messikommer (1942) depicts a quadriradiate form : this facies is said to be relatively common in the variety concerned (cf. Růžička, 1964).

Staurastrum simonyi Heimerl
Pl. 5, figs. 1-12.

Specimens of the «typical» form of this species, as described by Heimerl (1891), were encountered in small numbers on both sampling sites (pl. 5, fig. 1). They are characterized by two diverging terminal spines on the angles, and a crown of six paired spines on the apex of the triradiate semicells. The acute sinus is widely dilated outwards. The angles of the semicells are ornamented with two or three bands of small granules, in apical view giving the sides an undulated appearance (cf. Heimerl, 1891). In the studied material, however, *S. simonyi* appeared to be ▪ very variable species, and most of the specimens encountered are more or less differing from the typical form.

On site 1, the quadriradiate facies was more common than the triradiate facies (abundance : + and r, respectively). The quadriradiate specimens in frontal view show the same cell shape as the above mentioned typical triradiate form. The ornamentation with granules, however, is more or less reduced and in addition one of the terminal spines sometimes is hardly or not developed. In apical

view the sides of the semicells are concave and 8 paired apical spines are always present. (pl. 5, figs. 8-11). Similar quadriradiate forms have previously been reported by Dick (1923, as *S. monticulosum* Bréb. ?) and Yamagishi & Isoda (1968).

As concerns the triradiate specimens : apart from the above mentioned typical form, on the one hand forms were found that in apical view are more slender, with concave sides (pl. 5, fig. 2). On the other hand, however, a large number of forms were found with semicells that in frontal view are more or less semiglobose so that the sinus tends to be almost closed. Moreover, the apical spines are frequently somewhat reduced whereas the cell wall granules are mostly developed into small spinules which at times are doubled. The terminal spines on the angles of the semicells are commonly reduced, and in extreme forms only a group of small spinules is present (pl. 5, figs. 5-7). These forms are connected with the typical form by intermediates (pl. 5, figs. 3-4). Dimensions of the cells, without spines : length 17.5 - 23 µm, breadth 18 - 23 µm.

West (1899, under *S. reinschii* Roy, see Lütkemüller, 1900) and Homfeld (1929) already pointed to the great variability of *S. simonyi* and the figures of West (l. c.) are very similar to the present material. In my opinion, var. *gracile* Lütkem., var. *elegantius* Grönbl. and var. *spinosius* Grönbl. fall within the morphological range of the nominal variety (cf. Lütkemüller, 1893; Grönblad, 1920, 1948). Forms as depicted in pl. 5, fig. 7 are very much resembling those classified as *S. arnellii* Boldt var. *spiniferum* W. & G.S. West by Coesel

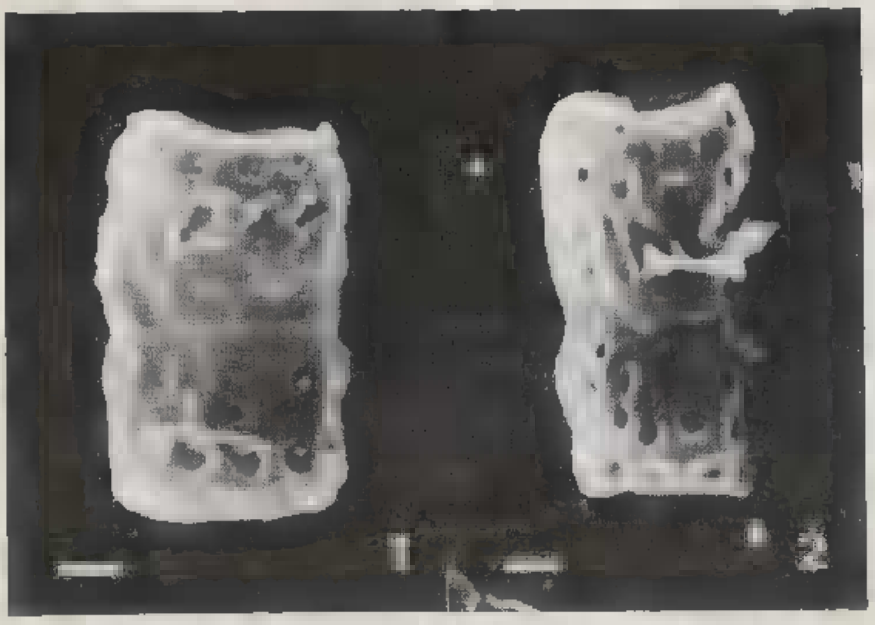

Plate 6 – Figs. 1-2 : *Actinotaenium geniculatum* spec. nov. SEM micrographs of two cells showing scrobiculae with pores on their wall. The cells are slightly deformed due to preparation. Scale bar represents 1 µm.

& Kooijman-Van Blokland (1976). Last mentioned taxon is poorly known and only a very few reports and figures are available (see also above, under *S. echinatum*). Intermediate forms between *S. simonyi* and *S. arnellii* var. *spiniferum, sensu* Coesel & Kooijman-Van Blokland (l.c.) have also been mentioned by Smit (1976).

DISCUSSION

During the present study in all 51 desmid taxa were encountered: 24 on site 1 and 50 on site 2. 23 taxa were found on both sampling sites (see Table I). Species composition on these sites is characteristic of acid and oligotrophic environment (cf. Coesel, 1975). Most of the taxa observed were present in their typical form and they showed no remarkable morphological variability. The find of several rare species with a poorly known morphology, however, gave occasion to some remarks.

On the other hand, a proportionally higher number of taxa possessed a very variable morphology; moreover they belonged to the most common species in the material studied. Such morphological variation, or polymorphism, may be induced by environmental factors. At the time of sampling both sites were more or less desiccated so that the algal material at daytime was exposed to high irradiance (ultra-violet !) and high temperatures. Playfair (1910) and Ducellier (1915) already mentioned the occurrence of a marked morphological variability in desmids in such environments, which they attributed to the high cell division activity. According to Lefèvre (1939), however, such aberrant or anomalous forms would rather be result of concentration of nutrients in desiccating pools. As can be seen from the figures, in the present material this variability does not always lead to the appearance of forms with a more simple morphology, or so-called «immature» forms, in which the semicells are not fully grown out to the typical form (cf. Ducellier, 1915). Evidently every single taxon reacts in its own way on suboptimal or changing environmental conditions.

Those taxa in the material under study that showed a supposed morphological reaction to extreme environmental conditions did so by merely changing their cell shape (*Actinotaenium subtile*), by developing extra spines (*Xanthidium tenuissimum, Staurodesmus extensus*) or by developing a more compact cell shape with reduced or aberrant ornamentation (*Staurastrum furcatum, S. simonyi*). In one taxon cell morphology was sometimes so much different that one can rather speak of monstrous forms, in which the development of the semicells was completely disturbed (*Staurodesmus extensus*). Some taxa showed variation in the degree of radiation, and two types could be distinguished. One type occurred in e. g. *Staurastrum margaritaceum* which with similar dimensions was 3-, 4- or 5-radiate. The other type occurred in *Cosmarium pygmaeum* and *C. sphagnicolum* : their triradiate cells had larger dimensions than the biradiate ones. In the first type variation in radiation might be the effect of fluctuations in temperature, while in the second type diploidy is a possible explanation

(see Brook, 1981, for a review on this subject). Teiling (1950) pointed out that triradiate forms of normally biradiate taxa are particularly known from arctic-alpine environment. If our triradiate *C. pigmaeum* and *C. sphagnicolum* indeed refer to stable diploid clones, they must not be classified as triradiate facies. In that case they have to be described as a true triradiate variety of the species in question (cf. Grönblad & Růžička, 1959; Růžička, 1975a). Unfortunately no chromosome counts are available. In a few taxa, on the contrary, a reduction of the degree of radiation with respect to the typical form had taken place : *Staurodesmus omearae, S. spencerianus, Staurastrum margaritaceum*. A combination of both variation in cell shape and ornamentation, and in degree of radiation occurred in *S. symonyi*.

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